



Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at <http://about.jstor.org/participate-jstor/individuals/early-journal-content>.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

THE
AMERICAN NATURALIST.

VOL. XV. — JULY, 1881. — No. 7.

ORIGIN AND DESCENT OF THE HUMAN BRAIN.¹

BY S. V. CLEVINGER, M.D.

THE object of this paper is to present to comparative anatomists certain aspects in the phylogenesis of the spinal cord, which culminate in the development of the brain of man.

The word brain is here used to include only the nerves and ganglia of the skull. The term has been applied so loosely that Professor Wilder rightly advises its discontinuance from neurological nomenclature.

Briefly stated, the nerves interrelate the muscles as the muscles interrelate the bones, nerves further are internuncial in conveying external or internal molecular vibrations to irritable or contractile tissues.

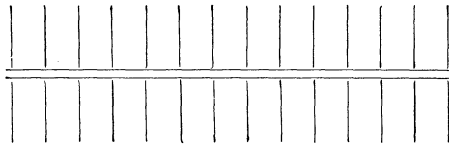
Biological investigations enable us to approach very closely the border land of sensation and molecular physics. While the physicist is striving to reduce his laws of sound, heat, light, electricity and gravitation to their ultimates, the biologist is meeting him over consideration of the forces which control the motions of the *Amœba* or evolve the animal from the cell.

In the *Journal of the Royal Microscopical Society* (Vol. III, No. 1, p. 63, from *Arch. Mikr. Anat.*, xvii, 1879, p. 58) are diagrams of the simplest acoustic and visual cells. These forms of nerve cells proceed from a still simpler protoplasmic cell, which, according to situation or the influences brought to bear upon it,

¹ Read before the Chicago Academy of Sciences, February 8, 1881.

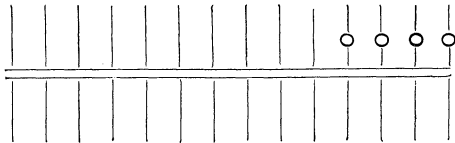
can as well develop into muscle, cartilage, cuticle or bone. It is the position of the cell and its environment which in embryology, as well as in phylogeny, determines what the cell shall become. The unity of the forces at work in nature are very evident to the biologist as well as to the physicist. But we must pass on to the main subject with the statement that after an orderly method of aggregation, certain protoplasmic cells arrange themselves along the dorsum of the embryo in the egg, and a spinal cord is formed.

The simplest spinal cord is owned by the *Amphioxus*, a vertebrate lower than the lamprey of our lakes. This fish-like animal has no brain. Extended the length of the body, is the cord, and nerves enter it dorsally and ventrally; the second pair of nerves of the head end pass caudally. Those along the back in this diagram are sensory, the lowermost being motor :



Owen compares these longer nerves to the *nervus lateralis* of the cod. He mentions them also as nerves of association comparable to the trigeminal and vagal.

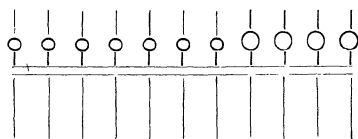
The cord of the lamprey (*Petromyzon fluviatilis*) is quite rudimentary, but a distinct brain presents itself in this case for analysis. We find certain intumescences attached to the spinal cord at the head end, which can be represented schematically thus:



The real appearance of these ganglionic swellings, for such they are, resembles the embryonic fusion of cerebral and spinal ganglia. A very important revelation concerning the homologies of these tubercles, I hope to be able to present to the next meeting of the American Neurological Society.

Notice that in this low vertebrate form, these enlargements on the sensory or ingoing nerves, occur at the head.

A Teliost, the *Trigla adriatica*, affords an example of these same enlargements appearing all along the spinal column:



(The *lateral* fusion also between these ganglia in the head end, occurs among the intervertebral in *Orthogoriscus mola*.)

Taking a general survey of the piscine and amphibian brains, we find, in many, these ganglia well defined as rounded, symmetrically placed bodies (*Lepidosteus*, *Amblyopsis*, *Leuciscus*), while in others these lobes are distorted, by elongation or cramping, in all directions (sturgeon, chimæra, sharks), and in still others, some of the lobes are pushed below the usual site (cod, herring, perch). Of necessity the ventricles must often be partially or wholly obliterated, showing the inexpediency of making use of ventricular passages in homologizing.

This crowding together, fusion and distortion of ganglionic lobes, obtains throughout animal life, and the olfactory lobe is often so closely fused with the prosencephalon as to afford us no line of separation. An interesting point in this connection is presented by the corpora bigemina, which lie upon the upper surface of the brain in reptiles, being succeeded in birds by these bodies being thrown down to the sides and base of the brain, crowded there by the greater relative size of the superior lobes.

The intervertebral ganglia which develop on the afferent nerves of the higher vertebrates undergo great development within the cranium, and by lateral crowding together, the median line of separation is obliterated, giving us the large central lobe of the shark and birds. Two or more of these ganglia may develop upon the same sensory strand (see Davida, *Centralblatt*, No. 26). The subsequent lateral lobes of the cerebellum can be resolved either into secondary or primary ganglia, or a mixture of both, certainly the vagus tubercle of the fox shark is in all essentials the pneumogastric lobule of man's cerebellum, the flocculus.

Thus it appears that by the pressure together of a number of these posterior spinal nerve root swellings a cerebellum has been formed. The cerebellum is now generally conceded to be a co-ordinator of sensation for cranial sensory nerves, and how can it be otherwise from this view? By this coalescence of interverte-

bral bodies it necessarily follows that sensations passing in from a variety of points must be distributed to a wider area of central points in the medulla and spinal cord. This explains why injury to the lateral lobes may occur without manifestation of the lesion and why a disorder of the central lobe or vermis produces a staggering gait. The main bundles of ingoing nerves are gathered in the latter region, while the plexus of fibers in the lateral lobes afford many avenues for impulse passage, other than those injured or destroyed. The original globular appearance of the lobes composing the cerebellum may be well made out in most quadrupedal forms, but as we pass to man we see that these lobes have become compressed into laminæ.

In a previous paper (presented to the American Association for the Advancement of Science, Boston, August 28, 1880, published in the *Journal of Nervous and Mental Disease*, October, 1880, and *AMERICAN NATURALIST*, January and February, 1881), I endeavored to show that all tubercles of the vertebrate brain fall within this category of intervertebral, a notable instance being the Gasserian ganglion. Mr. A. Milnes Marshall (*Monthly Microscopical Journal*, London, October, 1877), in an article "On the development of the nerves of the chick," shows plainly that the olfactory nerve must be considered homologous with spinal nerves, for it is similarly developed and in no way differs from a spinal nerve. Nor does the comparison rest here, for the lobe (not bulb) of the mammalian olfactory may be seen to be developed between the central tubular gray and the periphery just as is an invertebral. As to internal structure, the law of differentiation shows that subsequently acquired differences are not arguments against original derivation, for what can be more unlike than bone and cartilage, skull and vertebræ or hand and foot? And yet the one is a developed or differentiated condition of the other.

Thus the mammillary eminences, the epiphysis, the optic and post-optic lobes were originally intervertebral, and the olivary body embedded in the spinal gray is another related particularly to innervation of the tongue. It is very large in the parrot and has relation to the ability of that bird to articulate. But the most general interest centers in this large mass of nerve fibers and cells called the cerebrum. In the *Ornithorynchus*, it is smooth and simple in form, but the beaver also has an unconvoluted brain,

which shows at once the folly of attaching psychological importance to the number and intricacy of folds in animal brains. With phrenology, which finds bibativeness in the mastoid process of the temporal bone and amativeness in the occipital ridge, the convolutional controversies must die out, as has the old so-called science of palmistry, which read one's fate and fortune in the skin-folds of the hand.

The most noticeable change in form, as we pass up the scale of mammalian life, occurs in the production of the fissure of Sylvius. In most quadrupeds the olfactory lobe fills up largely the anterior part of the cranium. As the smelling sense diminishes this lobe degenerates to a mere tract and the frontal lobe of the brain increases in size, lifting the forehead into a vertical plane. The medulla is pushed forward to a less oblique angle with the front of the brain, from Lemuridæ to chimpanzee and man, and the frontal lobe pressure covers the cerebellum with the backward progress of occipital, till finally the occipital forms the temporal by curling under and forwards, forming the Sylvian fissure. These stages of progress are evident in the horse, elephant and human embryo. Often, in idiots, we find through want of development of this frontal lobe, that ossification takes place in a plane inclined at an angle corresponding with that of lower animals, and the cerebellum is uncovered. This is an adaptation of the skull to its contents, which, however, does not always take place. There are other elements at work to cause the skull to develop normally or even enlarge it abnormally, as for example, an accumulation of water in the ventricles will change the relative positions of the cranial bones to such an extent as to give to the hydrocephalic idiot the "front of Jove."

While the ontogenetic stages of development resemble strikingly the forms mentioned by Haeckel, the nervous system is not apparent in the embryo until we reach the ninth stage or Acranial, after this the cerebral vesicles rapidly develop and resemble in general the Cyclostome stage, and just as the sharks and mud fishes possess the intervertebral ganglia, which the hags and lampreys have not, the human fœtus, subsequent to the shaping of the cerebral vesicles, develops the posterior spinal nerve root swellings. From this point upward, it is easy enough to observe, that like the brains of marsupial adults, the cerebellum is at first uncovered, then by frontal lobe growth the temporal lobe is formed as in Simiadæ.